1,099,651

PATENT SPECIFICATION

DRAWINGS ATTACHED

1,099,651

Inventors: GILBERT NATHANIEL HARVEY and DAVID CHRISTOPER BEAVAN

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COMPLETE SPECIFICATION

Improvements in or relating to Gun Control apparatus

I, THE SECRETARY OF STATE FOR DEFENCE, formerly Her Majesty's Principal Secretary of State for the War Department, London, do hereby declare the invention, for which I pray that a patent may be granted me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to gun control apparatus.

In conventional guns, the barrel is normally mounted in a cradle which carries within it a pair of axially spaced cylindrical bearings in which the barrel is supported and recoils. The barrel is provided with a pair of arms connected to the operating rods of recoil cylinders and a key which engages in a long keyway to prevent rotation of the barrel during recoil and run out.

Aiming of the gun is normally achieved by moving the cradle, for example, by turning it in elevation about trunnions and by moving the trunnion bearings in traverse in a frame, such as a turret, about an axis at right angles to the centre line of the trunnions.

The present invention consists in providing, in addition to the normal elevating and traversing gear, a mechanism for applying to a gun barrel, small elevation and traverse movements relative to its cradle.

The desired movement may be produced by moving in a transverse plane of the cradle, one or both of the cylindrical bearings in which the barrel is supported. If both bearings are movable in opposition, the movement of either bearing to produce a given barrel movement will be less than that required by a single bearing moving relative to a second fixed bearing.

If the gun sight be attached to the cradle and be laid on the target, using the normal elevating and traversing gear, the additional mechanism may be employed to impart to the barrel further movement which may include some or all of the following:—

(a) Compensation for height and sideway offset between sight and barrel

(b) Compensation for barrel bend in elevation and traverse,

(c) Compensation for trunnion tilt,

(d) Compensation for drift;

and for guns having very high muzzle velocity and hence a very flat trajectory the movement may include super-elevation appropriate to the range. All the above factors can frequently be accounted for by a barrel movement of a fraction of a degree and, thus require only a very small relative movement of the cylindrical bearings.

The gun cradle, the sight, the rangefinder and the gun bend corrector may all be firmly secured to a single robust structure which can be moved as a whole in elevation and traverse, thus obviating the need for parallel link mechanisms and individual pivots such as are normally required in conventional gun control systems and which may cause inaccuracy due to backlash and uneven temperature effects. The action of lying the gun can also lay the rangefinder and the further aiming movement can be applied automatically without disturbing the lay of the sight. The relative angular movement of the barrel in the cradle entails slight freedom in the anchorage connecting the barrel to the recoil pistons and, also, a modification of the key which prevents barrel rotation to ensure that it does not move clear of the keyway on the cradle.

The required additional aiming movement may conveniently be broken down into two perpendicular components and may be applied by moving the cylindrical bearing or bearings by such convenient means as hydraulic or pneumatic rams; eccentrics driven hydraulically or by electric motors; screw gears or cam plates.

One form of apparatus, in accordance with the invention, for moving a gun barrel relative to its cradle will now be more particularly described, by way of example only, with refer-

ence to the accompanying drawings in which:—

Figure 1 is a longitudinal section, partly broken away, of the cradle,

Figure 2 is a section on the line II—II of Figure 1,

Figure 3 is a section on the line III—III of Figure 1,

Figure 4 is a detail of a hinge device alternative to that shown in Figure 1, and

Figure 5 is a partly sectioned elevation showing modifications to the recoil buffers.

The gun barrel 1 is carried in a cradle 2 by a pair of cylindrical bearings 3, 4. The cradle 2, mounted in known manner on a known type of carriage, has the usual arrangements for elevation and traverse. The mounting, which does not form part of the present invention, is not illustrated.

In the arrangement shown additional aiming movement of the gun is achieved by moving the rear bearing transversely within the cradle, causing the gun 1 to pivot about the front bearing 4. The gun can recoil in the bearings 3, 4 in the usual manner. In order to allow angular movement of the gun 1, the front bearing 4 may have a bore having a minimum diameter at its centre and increasing slightly towards each end so that the gun can pivot relative to the bearing; and/or the bearing may have a cylindrical bore and be mounted in a rubber bush 5 which is bonded to the outer surface of the bearing 4 and to the inner surface of the cradle 2 so that the bearing can pivot relative to the cradle.

The rear bearing 3 is hinged to the cradle 2 at its lowest point. A spigot 6, fixed into a ring 7 attached to the rear end of the cradle 2 has a ball end 8 projecting longitudinally internally of the cradle and engaging in a radial slot 9 in the rear face of the bearing 3. A second, similar spigot 10 is fixed to the wall of the cradle, below the bearing 3, and its ball end 11 projects radially into the cradle to engage a radial bore 12 near the forward end of the bearing 3. The centres of the ball ends 8, 11 of the spigots 6, 10 are aligned longitudinally of the cradle 2 and the required movement of the bearing 3 can be achieved by a combination of rotation about the common axis of the ball ends 8, 11 and transverse sliding movement of the bearing, up or down, relative to the ball ends 8, 11. In order to permit free movement of the bearing in the cradle a slight axial clearance is introduced between the bearing 3 on the one hand and the ring 7 and a forward stop ring 79 on the other hand. Similar clearances are introduced between the ball ends 8, 11 of the spigots 6, 10 and the forward and rearward faces of their sockets 9, 12. To eliminate transverse movement of the hinge transverse dimensions of the sockets may be a close fit on the spigot ends (e.g. the bore 12 may be rectangular in cross-section) or as shown in Figure 2, adjustable screws 80, carried by the bearing 3, may project into the bore 12 so that their end faces bear on the ball ends 8, 11. This latter arrangement permits accurate fitting of the hinge spigots without the necessity of accurate dimensioning of the slot 9 and bore 12.

An alternative hinge, shown in Figure 4, comprises a hinge bar 13 attached by hinge pins 14, 15 to the cradle 2 and bearing 3 respectively. In this case the required movement involves a combination of rotations about the pins 14, 15.

The bearing 3 is further supported by two sets of pistons carried in the cradle and by means of which the required movement is applied to the bearing. The first set for applying elevational movement to the bearing comprises four pistons 16, 17, 18, 19 (Figure 2) arranged in two opposed pairs. The pistons of each pair are coaxial their common axis being substantially tangential to the bearing 3 and lying in a transverse plane thereof. The axes of the two pairs are arranged symmetrically, one on either side of the bearing diameter which intersects the spigots 6, 10 of Figure 1 or the hinge pin 15 of Figure 4.

Each piston is carried in a cylinder mounted in, or forming part of, the wall of the cradle 2. Each cylinder 20, 21, 22, 23 has a bore extending through the cradle wall tangentially to the bearing 3 and is closed at its outer end by a plug 24, the bores being in communication with various hydraulic feed pipes 25.

Each piston extends from its cylinder internally of the cradle 2 and bears on a roller 26 carried by an axle 27 mounted longitudinally in the bearing 3. Extension or retraction of the upper pistons 16, 17 of each pair and retraction or extension of the corresponding opposed pistons 18, 19 causes the bearing 3 to move parallel to the piston axes to elevate or depress the gun barrel 1.

The second set of pistons, for applying traverse movement, comprises a single pair of opposed pistons 28, 29 shown in Figure 3. The common axis of these pistons is at right angles to the axes of the pistons of the first set and is tangential to the bearing on the side thereof remote from the hinge. The construction of pistons 28, 29 cylinders 30, 31 and rollers 32 is similar to that described for the first set. Extension or retraction of one piston 28 with a similar retraction or extension of the opposed piston 29 moves the bearing 3 in traverse by rotation about the hinge.

Both cylinders of each opposed pair may be connected to a hydraulic actuator arranged to force fluid into one cylinder and simultaneously withdraw fluid from the opposed cylinder through pipes 25. Alternatively, one cylinder of each pair maybe connected to an actuator, the opposed cylinder being connected to a storage cylinder in which the pressure is maintained at a convenient level such that a

reduction in pressure in the driving cylinder causes fluid to be forced, from the storage cylinder into the opposed cylinder. The pistons of each pair may be of the same or, as shown, of different cross-sectional area so that the operating pressure levels of the two cylinders may be related according to the requirements of the hydraulic arrangements.

The supply of pressure fluid may be controlled by means of a closed loop servo mechanism operating in response to signals from a known type of computer control apparatus. Such control apparatus is well known and forms no parts of the present invention.

In order to avoid undesirable movement of the bearing 3 in the cradle when the control apparatus is not in use, for example during travelling, a locking wedge 33 is provided for retaining the bearing in its central position. The wedge 33 is cylindrical in form and can slide within the cradle 2. The outer surface of its rearward end is stepped and chamfered at 34 to fit within a complimentarily stepped and chamfered forward end 35 of the rear bearing 3. A ring 36 is fixed to the inner surface of the cradle 2, forward of the wedge 33, by locking pins 37. Forward of the fixed ring 36 is a longitudinally movable ring 38 connected to the wedge 33 by tie bolts 39 which pass through holes 40 in the fixed ring 36. Coil springs 41, in compression between the wedge 33 and the fixed ring 36 urge the wedge rearwards towards its locking position. The springs 41 are located in longitudinal bores 42 in the wedge the forward end of each spring being centred in a recess 43 in the rear face of the fixed ring 36. Any suitable number of springs and tie bolts may be used, symmetrically spaced around the wedge 33. Before operation of the control mechanism the wedge 33 is withdrawn from engagement with the bearing 3 by means of small pistons or jacks 44 housed in cylinders 45 formed in the forward face of the fixed ring 36, which jacks bear on the rear face of the movable ring 38 and when extended, as shown, cause the rings 38 and the wedge 33 to move forward against the force of the spring 41 to free the bearing 3. The jacks 44 may be operated hydraulically, the cylinders 45 being connected to a hydraulic system through channels 46. The hydraulic system operating the jacks 44 may be connected to or independent of the system which operates the control pistons.

Various modifications of the locking wedge may be employed. For example, the male and female roles of wedge and bearing may be interchanged by reversing the steps and chamfers of their ends. In a further modification the cylindrical wedge may be divided by longitudinal cuts into a pluraity of separate wedges.

A small amount of play is allowed between the gun 1 and the bearing 3 to enable the gun to recoil freely in the bearing. Since movement of the gun transversely relative to the bearing would be detrimental to accuracy, a spring loaded pressure pad 47 is inserted in the lower part of the wall of the bearing to maintain the gun against the upper part of the bearing during aiming. The pressure pad 47 is located in a recess 48 in the inner face of the bearing 3 and is urged upwardly by a spring device 49 which, as shown, comprises a pair of cupped washers one of which is inverted. The spring device 49 surrounds a boss 50 on the upper end of a plug 51 screwed into the wall of the bearing 3. The plug 51 carries a downwardly extending spigot 52 having a hexagon end 53 which is accessible for engagement by a spanner. The plug 51 is locked in position by a cylindrical locknut 54 having tommy bar holes 55 at its accessible end. In some cases, for example where the centre of gravity of the gun 1 is sufficiently forward to hold the gun against the upper part of the bearing 3, the pressure pad may be unnecessary.

The cradle carries at its rearward end a bracket 56 to which is attached a rearward extension 57 extending rearwardly and having a rectangular keyway 58 in its upper surface. Normally the gun 1 carries a rigid key which slides rearwardly in the keyway on recoil to prevent rotation of the gun about its axis. To allow for the slight misalignment of gun and keyway due to the applied aiming movement the key 59 which is fixed to the gun 1 is provided with a ball or barrel shaped end 60 carried in a slider 61 located in the channel 58. Vertical misalignment is catered for by sliding movement of the slider 61, up or down, in the channel 58 and transverse misalignment is catered for by rotation of the ball end 60 in the slider 61 accompanied by a very slight, permissible, rotation of the gun barrel.

The misalignment of gun and cradle also entails a slight modification of the recoil system shown in Figure 5. The cradle 2 and recoil cylinders 62 are mounted in sockets in a mantlet 63. The end of each recoil cylinder 62 is provided with a sleeve 64 having spherical surfaces 65 formed at its forward and rear ends. The sleeve 64 is mounted in a socket 66 in the mantlet 63 between rings 67, 68 having concave spherical surfaces 69 mating with the surfaces 65 of the sleeve 64 so that the recoil cylinder 62 can pivot to a limited extent about the common centre of the surfaces 65, 69. The piston rod 70 of the recoil system is mounted in a bracket 71 bolted to the breech block 72 of the gun 1. A sleeve 73, screwed to the piston rod 70 and locked by a nut 74 has a spherical surface 75 at its forward end which mates with a concave spherical surface 76 formed in a ring 77 inserted in a recess 78 in the bracket 71. The rod 70 can thus undergo a limited pivotal movement in the bracket 71.

It will be understood that numerous modifications may be made to the aforementioned arrangement without departing from the scope of the invention.

WHAT I CLAIM IS:—

1. A gun control apparatus wherein is provided, in addition to the normal elevating and traversing gear, a mechanism for aplying to the gun barrel, small elevation and traverse movements relative to its cradle.

2. A gun cradle apparatus as claimed in Claim 1 wherein the said mechanism includes a plurality of hydraulically actuated pistons housed in the cradle, movement of which pistons applies the required movements to the gun barrel.

3. A gun barrel apparatus as claimed in Claim 2 wherein the pistons are arranged in two sets each set acting transversely of the cradle, the axes of the pistons of one set being perpendicular to the axes of the pistons of the second set.

4. A gun control apparatus as claimed in any one of Claims 1 to 3 wherein the said mechanism is arranged to move, transversely of the cradle, one of a pair of longitudinally spaced bearings in which the gun is mounted within the cradle, the second bearing of the pair being arranged to provide a pivot about which the gun can move angularly relative to the cradle axis.

5. A gun control apparatus as claimed in Claim 4 wherein the bearing on which the mechanism operates is connected to the cradle by a hinge which allows both elevation and traverse movements of the bearing.

6. A gun control apparatus constructed, arranged and adapted to operate substantially as hereinbefore described with reference to the accompanying drawings.

R. G. CHANNEN,
Chartered Patent Agent,
Agent for Applicant,
Ministry of Aviation,
Patents 1,
First Avenue House,
High Holborn, W.C.1.

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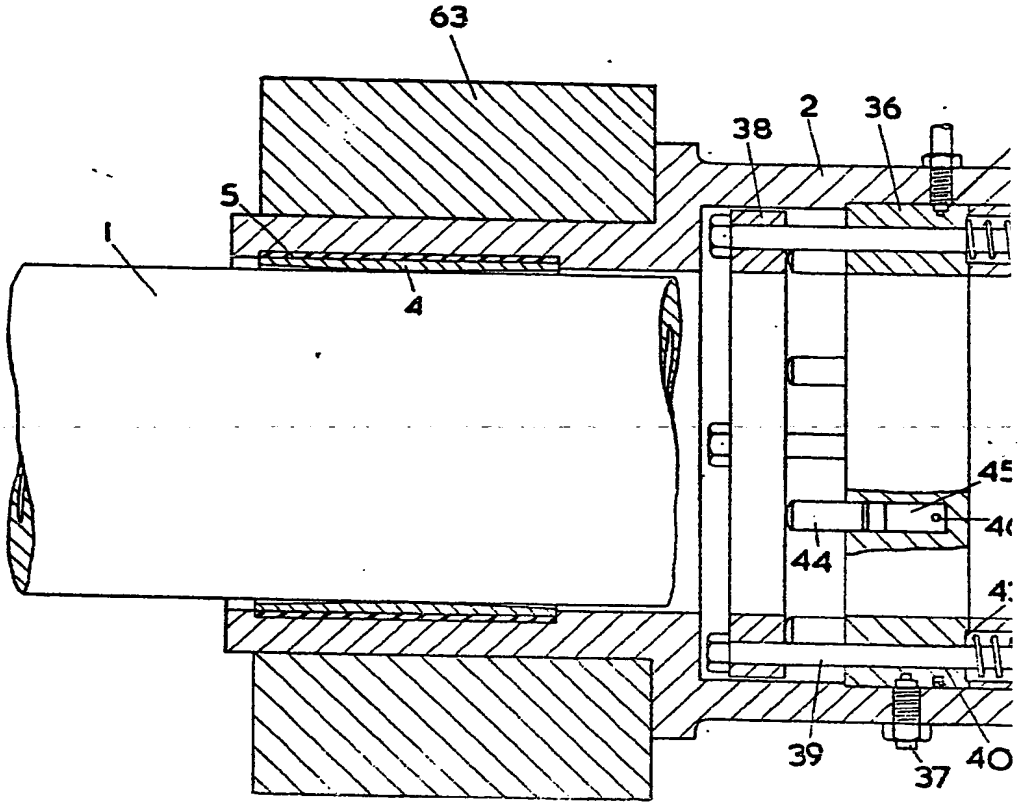

FIG. 1.

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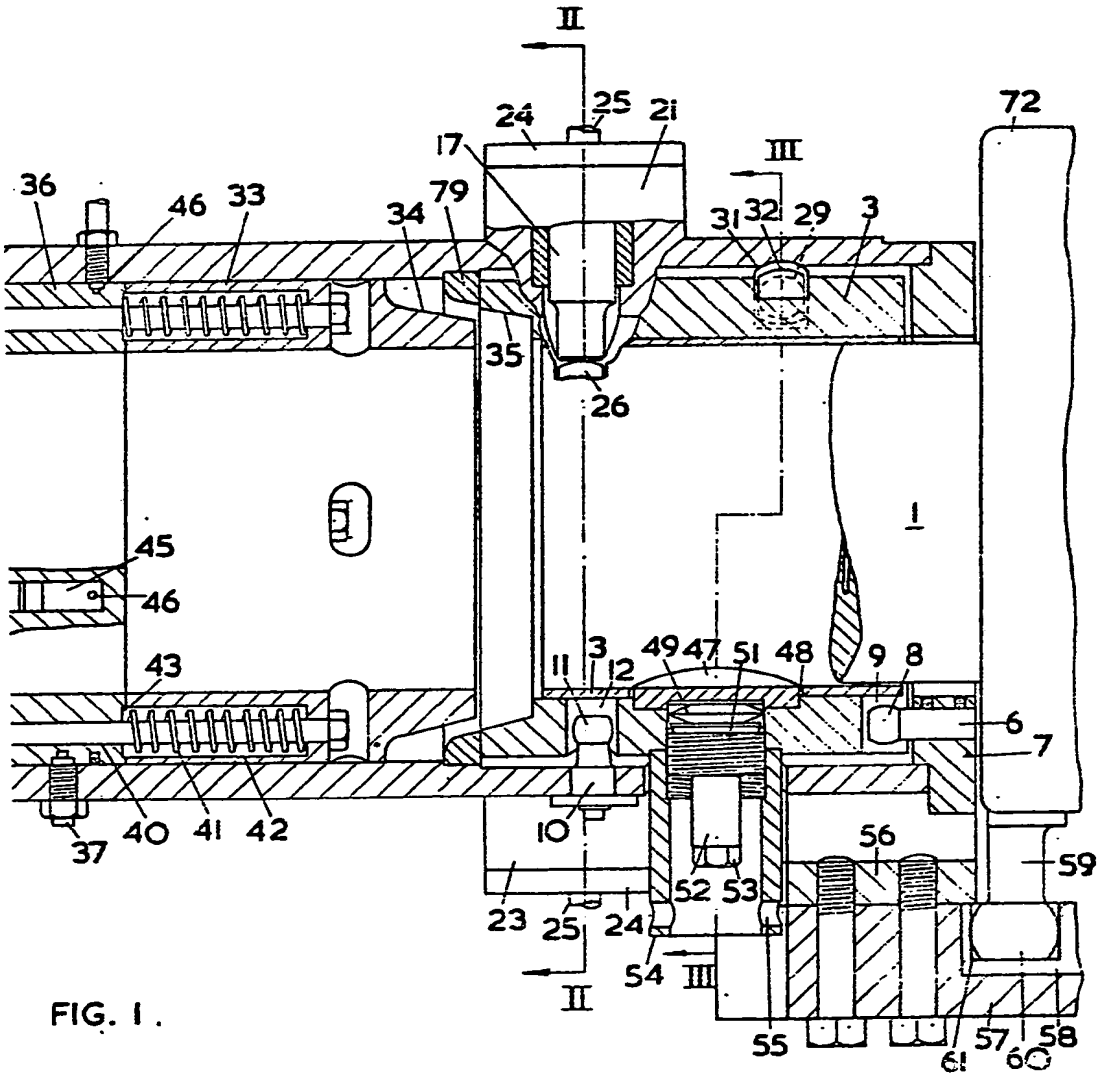
Sheet 1



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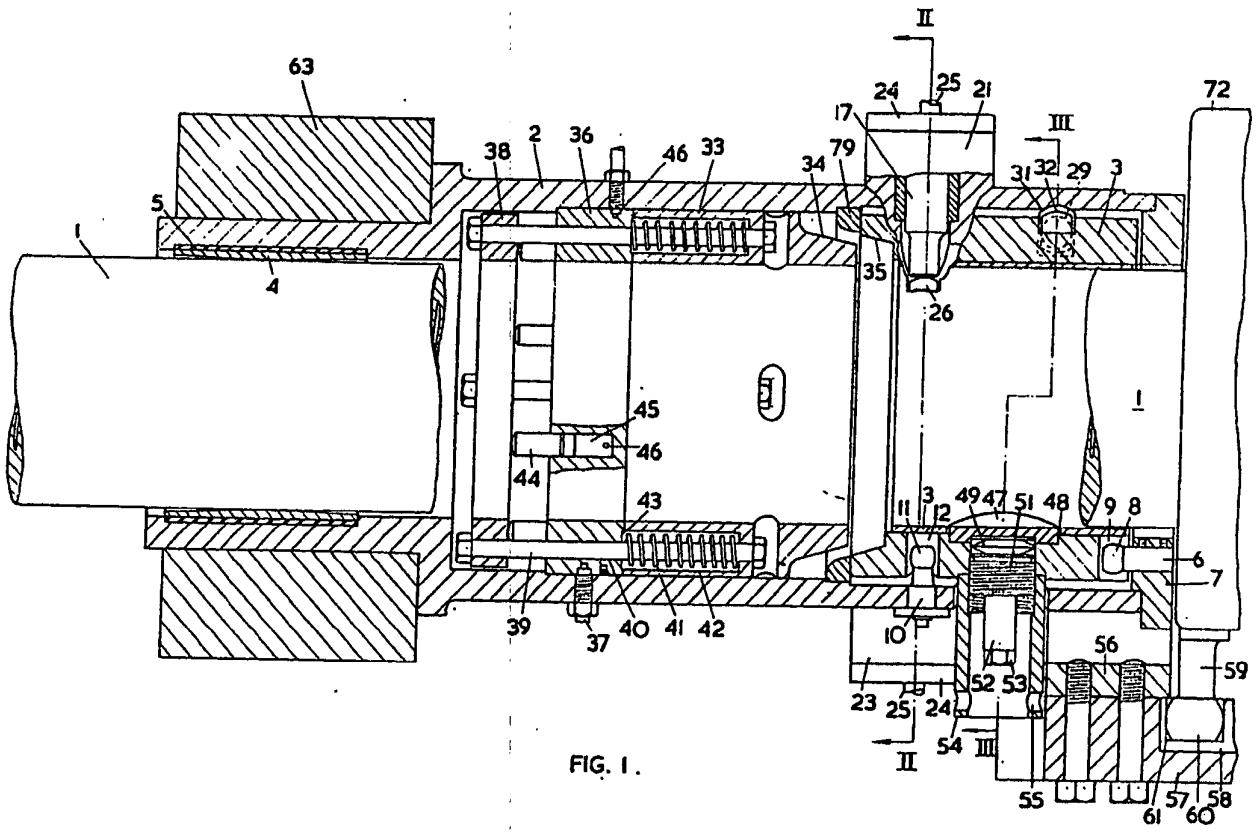

FIG. 1.

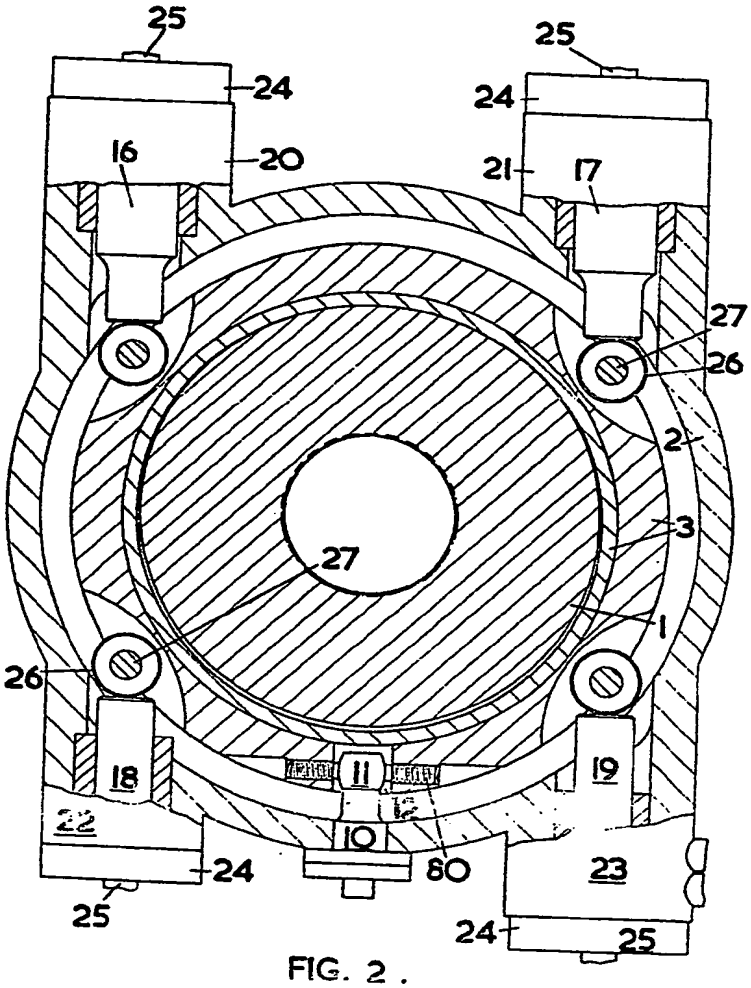

FIG. 2.

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Sheets 2 & 3

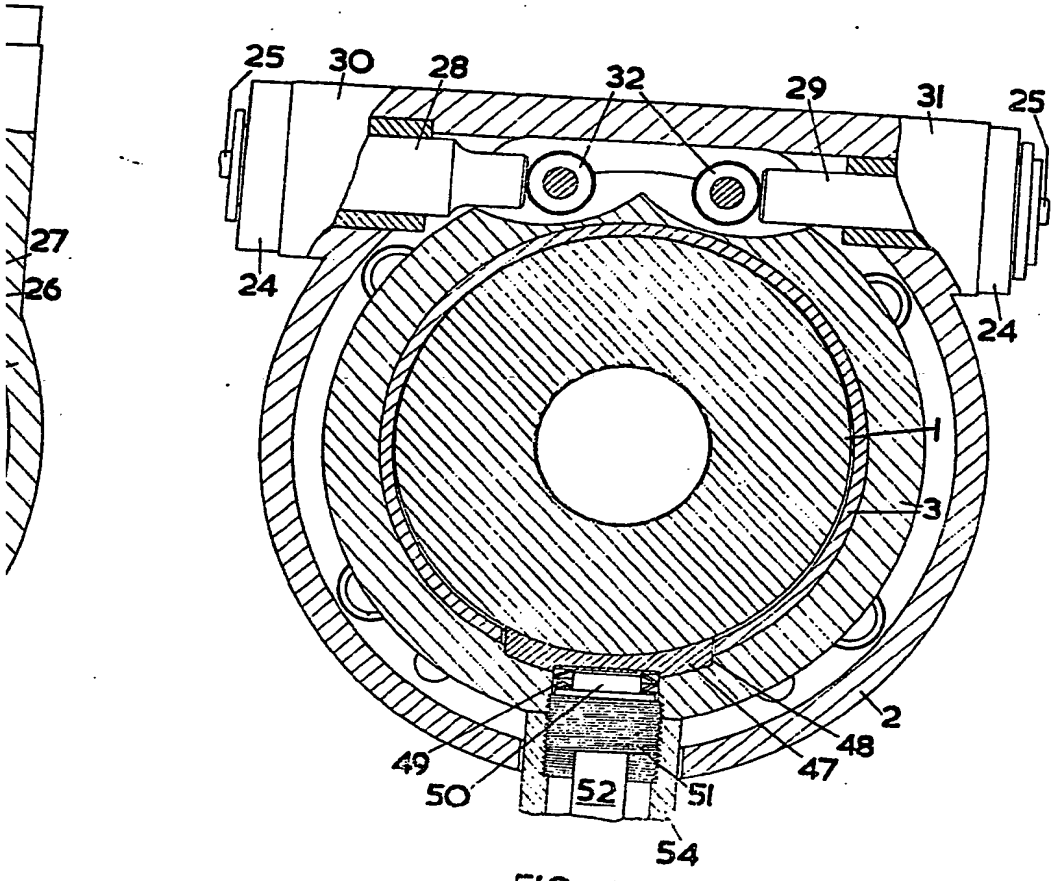

FIG. 3.

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Sheets 2 & 3

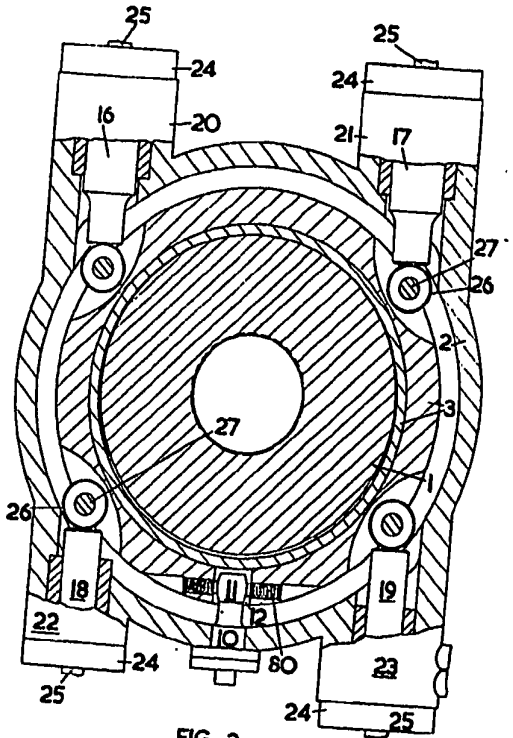

FIG. 2.

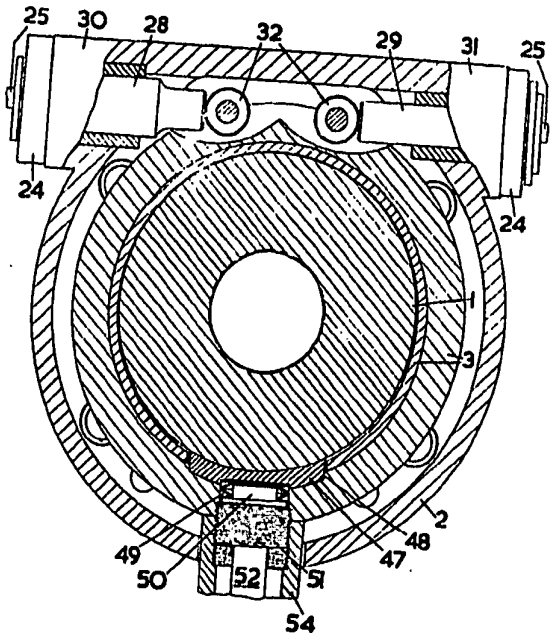

FIG. 3.

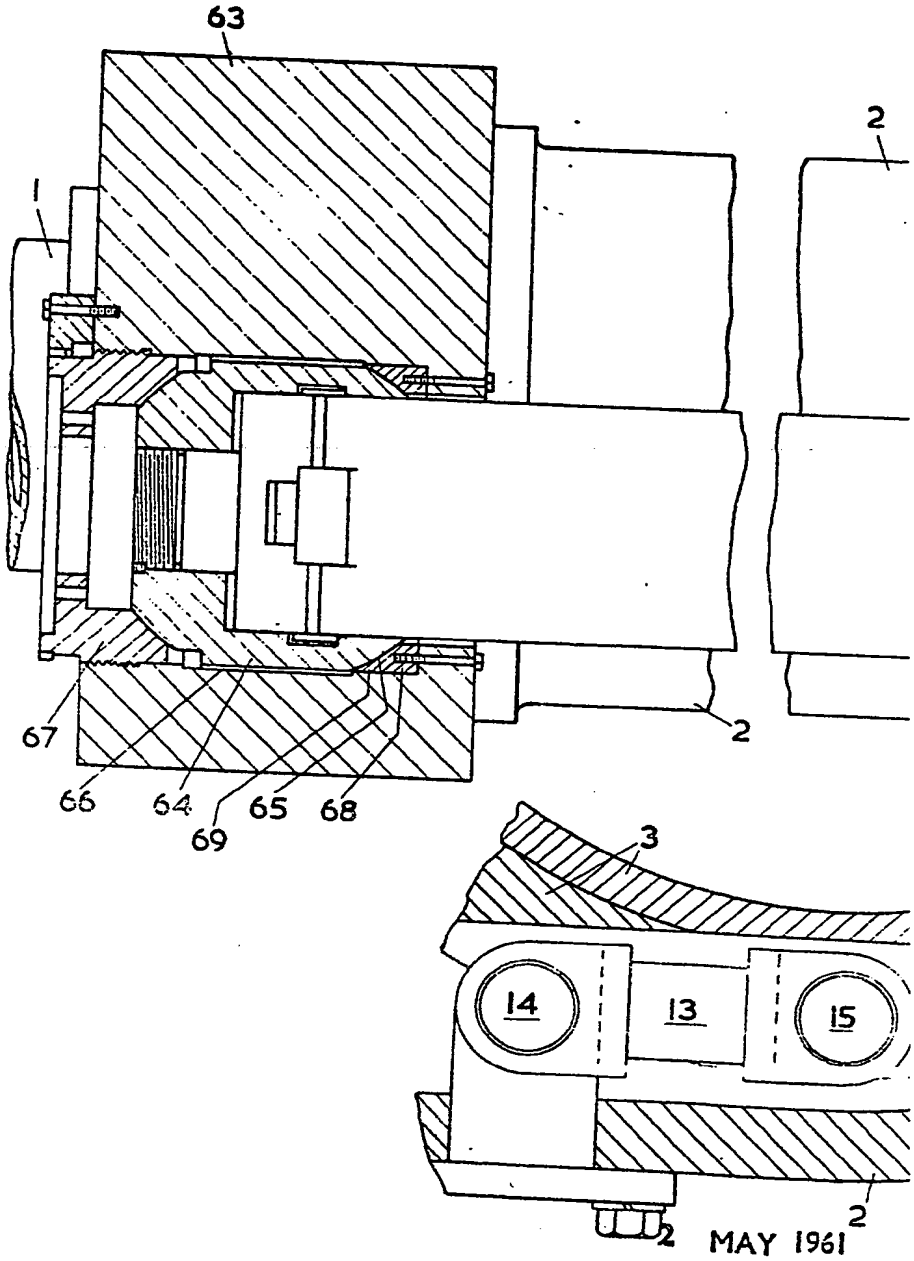

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FIG. 4

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Sheet 4

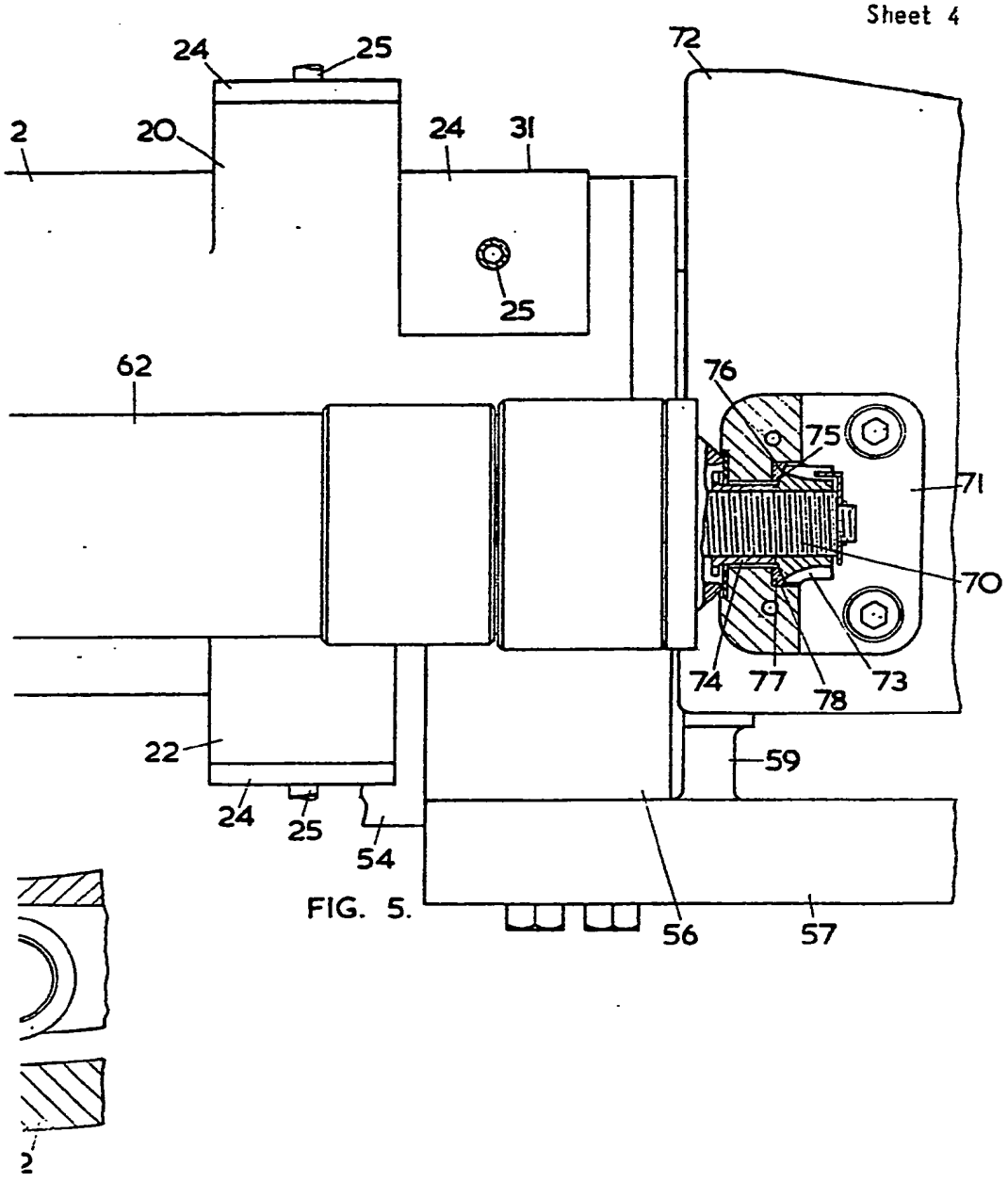

FIG. 5.

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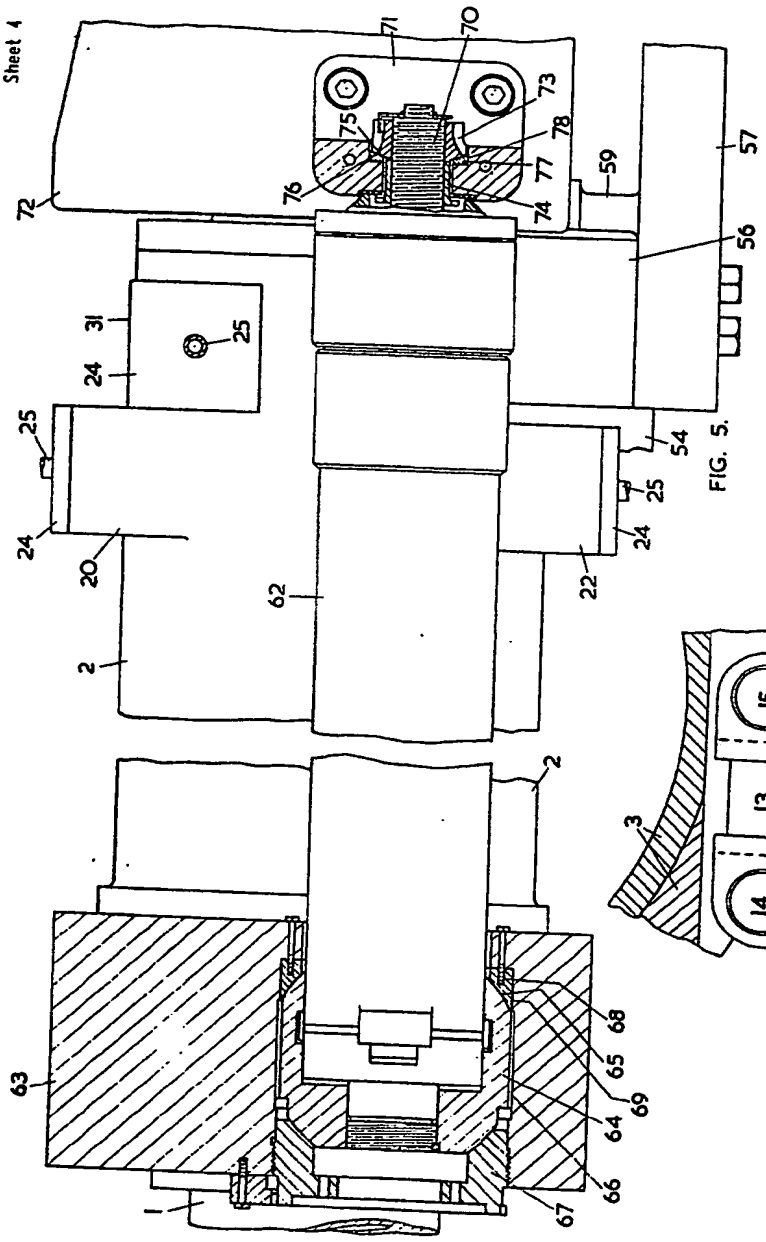

FIG. 5.

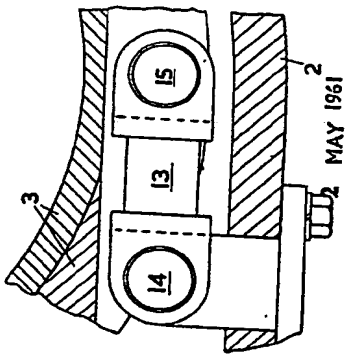

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FIG.4